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Transfer of Training Revisited

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The research note contains a literature review of research on the transfer of training; it is intended for use by educational researchers and psychologists. The note includes information and comments on the relevance of transfer of training to what it labels as Army XXI environments, i.e., environments that might be found in the Army in the future and similar to those in what have been called the digital force and the objective force. The note presents different conceptualizations and measures of the construct of transfer of training, criticism of experimental findings in the area, a listing of the instructional and non-instructional sources of variation in the transfer of training, transfer enhancement through constructivist methods, additional thinking skills research, and the role of technology. Future research directions are suggested.

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TRANSFER OF TRAINING REVISITED

Introduction

This research note is a review of recent academic and military literature on the transfer of training and adaptability. The purpose of the review is to address specific questions about the transfer of training that can lead to an identification of research issues and help in designing future research in support of Army training. This review addresses four primary questions: 1) What will be the characteristics of future Army environments in which transfer-of-training principles and guidelines must be applied? 2) What accounts for the inconsistency that has been found in the transfer-of-training experimental literature? 3) What are the major sources of variance in transfer of training? and 4) How relevant is the existing research literature to training for the digital environments of the future Army (similar to, in general, such concepts as Army XXI, the digital force, and, later, the objective force)? This research note was prepared as part of a wider, ongoing U.S. Army Research Institute research project entitled TRAINDIGITAL: Principles and Strategies for Training Digital Skills. Its goal is to identify and document training principles and strategies that maximize the acquisition, adaptability (i.e., generalizability), transfer, and retention of digital skills for soldiers and leaders in the 21st Century Army.

Future Army Environments

The Army will face an ever-changing environment where soldiers and leaders will have to respond with increasing frequency to complex, novel problems and situations. Understanding these operational changes is critical to developing transfer of training principles and guidelines for the 21st Century. To better understand what these changes will be, the authors reviewed the literature on past and current contingency operations as well as copies of briefings to or by the Army's senior leadership. What follows is a summary of what was found in these reviews.

Since the end of the Cold War, the operational missions of the Army have changed. Training has lagged behind in preparing soldiers for the new and changing nature of these missions. Present-day missions are increasingly complex and differ from missions of the past due to such factors as technological innovation and a changing definition of national security (Bacevich, 1999; Laurenzo, 1999; Reimer, 1999). According to the recent Chief of Staff of the Army (Reimer, 1999), in testimony before Congress, the Army must be prepared to respond to conventional Cold War challenges, but also to challenges such as asymmetric threats, humanitarian missions, and peacekeeping operations. Additionally, complications result from limited resources and the difficulty of keeping forces readily deployable. Recent complex missions have been described as requiring flexible, adaptive, decisive soldiers (Allen, 1999; Laurenzo, 1999; Reimer, 1999; Wood, 1999). It has been charged that much of this recognized complexity in recent missions is due to the inappropriate structure of the armed forces, which are seemingly operating according to Cold War doctrine and strategy (Bacevich, 1999). However, one view sees difficulties as inevitable due to increased participation in Operations Other Than War (OOTW) that are, by their nature, often ambiguous, unpredictable, and without the traditional, "comfortable" structure of combat operations (Wentz, 1997).

Complexity and complications are noted through issues such as changes in doctrinal templates, soldier skills, tempo, proliferation of roles, budget constraints, and changing technology. Consequently, job descriptions for Army personnel have changed dramatically in recent years (Bacevich, 1999; Builder, 1999; Laurenzo, 1999; Reimer, 1999). The Army is no longer a force deployed mainly for large-scale combat missions. It is increasingly called upon to address post-Cold War national interests through peacekeeping missions, humanitarian missions, and other varying aims (Laurenzo, 1999) and handle changing threats such as asymmetric (dissimilar forces, weapons, and tactics) operations (Allen, 1999; Reimer, 1999; Wood, 1999).

Traditional training for combat operations is still necessary to meet threats requiring standard force-on-force, but training, however difficult, is now also necessary to create adaptive soldiers and to take advantage of technological opportunities such as digitization (Allen, 1999; Reimer, 1999; Wood, 1999). In particular, there is a need for rapidly deployable forces with adaptive leaders and soldiers that have broad, multidimensional skill sets. These skills include complex decision making skills, flexible thinking, high technology skills, and the ability to learn rapidly (Allen, 1999; Wood, 1999). Soldiers and leaders with these types of skills will be better able to deal with complex missions and technologies.

Technological innovations have changed the speed and tempo of operations, thus increasing the need for quick, yet critical thinking on the part of Army personnel (see Wood, 1999). Further, soldiers deployed recently to Bosnia described the proliferation and complexity of their roles as burdensome (Foley & Steinberg, 1998). Soldiers felt that they spent an inordinate amount of time on non-specialty tasks such as guard duty and sandbag construction and repair. In addition, many of these soldiers felt that they needed more training to deal with unexpected situations arising from local residents, language difficulties, and difficulties with the physical environment. Soldiers perceived that many of their difficulties were due to lack of training for their specific work environment. They were forced to come up with quick solutions through the use of adaptive thinking and critical decision making skills. As outlined by Wood (1999), perhaps training programs geared toward flexibility and decision making skills applicable to general situations are the answer to these increased job requirements.

Recent conflicts, such as in Kosovo, have been marked by occurrences that speak to the unexpected nature of events during missions. For example, Russian occupation of the Pristina Airport and the aftermath of the bombing of the Chinese embassy were unexpected events and, undoubtedly, required swift decision making on the part of NATO soldiers as to how to conduct their daily business. The accidental killing of celebrating Albanians by two British soldiers who misperceived a threat made worldwide headlines. This example shows the potential impact of erroneous military actions at the lowest echelon and rank levels. Peacekeeping operations must be conducted under doctrine, procedures and intelligence operations specific to that type of mission rather than that of a traditional combat mission. Also, training must be provided for high technology innovations so that, for example, information overload does not occur and the technology can be integrated into the setting. It is imperative for personnel working in complex missions to understand how to best use and communicate via the latest technology.

The senior leadership of the Army has determined that the traditional "what-to-think" training paradigm, while still essential, is not sufficient. A shift to "how-to-think" methods is

essential for preparing a diverse, flexible set of soldier and leader skills that can address the complexities of the future Army digital environment. In an effort to fully understand the implications of the emerging digital environment of the Army, it is necessary to identify key issues and areas of debate in the research on training and transfer of knowledge. In general, attention is directed toward instructional content, organizational factors, and psychological variables for the development of optimal environments for transfer. Identified factors are not specific to digital environments but viewed as general principles of instruction and learning applicable to all environments. Training designed with these factors in mind ought to prove to be cost-effective and efficient for the Army in its expansion into digitization.

Transfer of Training

The Army needs its trainees to be able to use their knowledge and skills in new situations outside of the original training context. Researchers have described several factors deemed essential to the promotion of this transfer of training. While these factors are generally accepted, differential results in the literature regarding the effectiveness and frequency of transfer in experimental and training situations (Ghodsian, Bjork, & Benjamin, 1997) make it necessary to explore the manner in which transfer has been conceptualized by various authors and what constitutes "true" transfer. In general, the training and organization literatures (e.g., Baldwin & Ford, 1988; Foxon, 1993, 1994) define transfer in terms of evidence of changed work behavior as a result of training interventions.

The cognitive psychology experimental literature generally views transfer as the degree to which a behavior will be repeated in a new situation (e.g., Cox, 1997; Detterman, 1993). The issue of similarity is viewed as essential to the concept of transfer. Basically, transfer is more likely to occur the more two situations share common elements (Thorndike & Woodworth, 1901). *True transfer* of training occurs when the behavior transfers between two discrete, novel situations. In contrast, *learning* occurs when the behavior transfers between two identical situations (Detterman, 1993). This type of distinction is also exemplified in the discussion of near transfer versus far transfer (Detterman,1993; Orey et al., 1995). Near transfer is considered that which is between nearly identical situations, and far transfer is transfer between novel contexts. Those who propose the relative nonexistence of transfer (Detterman, 1993), view most evidence of transfer as merely evidence of learning. In other words, those who cite evidence of transfer are citing instances of near transfer and not the less likely occurrence of far transfer (Detterman, 1993). However, no situation is completely identical. Thus, in reality, transfer to novel contexts can be seen in every instance.

Foxon (1993) proposed a novel approach to the concept of transfer. Foxon sees transfer as a series of stages through which the learner passes. Most others view transfer as a direct result of instruction; it either occurs or does not occur. Foxon (1993) posits that trainees progress from an intention to transfer to partial transfer, to conscious maintenance, and finally to unconscious maintenance. Learners progress from end-of-training motivation, then to attempts to apply the training, to sporadic transfer, to maintenance of skill application. Each progressive stage represents a greater degree of transfer and lower chance of transfer failure. Thus, those seeking to measure transfer have several points along a continuum at which they can judge whether and

how much transfer has occurred. In the traditional transfer-as-product approach, measurement is restricted to a single judgment of whether transfer has occurred or not.

Criticism of Experimental Findings

To view the transfer literature critically, it is necessary to question the existence of transfer in the real world. Detterman (1993) has expressed his general disregard for many research programs in the transfer-of-training area. He cites several factors for the inconsistent nature of the body of knowledge. His main argument is that several studies citing transfer describe methods that are not in keeping with a search for transfer. In many of the studies, the subjects were explicitly told of the solution to the problem or were given large amounts of assistance in finding the solution. Detterman notes that transfer cannot be a salient phenomenon if transfer occurs only when subjects are explicitly told the solution. This type of methodology does not require subjects to exhibit true transfer but only asks that subjects follow the instructions of the experimenters in order to solve the problem. Detterman believes that transfer is cited as occurring only in situations with extremely liberal definitions of transfer, and is even rare under this type of definition. He notes further that several transfer experiments are relevant only to a given experimental context and have no meaningful connection to any real-world situation. If transfer is found in such artificial circumstances, it is difficult to conclude that transfer is something that could happen outside of the experiment.

An additional criticism by Baldwin and Ford (1988) of much of the research on transfer of training is its neglect of issues about the measurement of transfer. It is important for researchers to establish criteria for specific research tasks in relation to expected objectives of the training course. Baldwin and Ford also note that it is critical for researchers to establish baselines for how often certain behaviors should be expected and the importance of particular criteria. In order to determine the true nature of transfer for a particular task, it is necessary to have general guidelines from which to measure performance.

Sources of Variance in Transfer of Training

Instructional Issues

One can scrutinize the literature on transfer to uncover elements of the training environment that may account for the relative existence or nonexistence of transfer. Several of these factors relate to instruction and point to what is necessary for transfer to occur.

General vs. specific. In addition to training Army personnel on specific skills for digital environments, general conceptual understandings must be taught (Baldwin & Ford, 1988; Gott & Glaser, 1985; Mirabella, Macpherson, & Patterson, 1989; Yelon, 1992). General principles become most useful when explicitly integrated with specific procedures (Mirabella et al.). During instruction, it is helpful for trainers to refer to the underlying principles behind each skill or task, so trainees understand how both aspects fit together. Awareness of general principles can be aided by giving trainees examples of how others have used the skills (Yelon, 1992) or by explaining proposed reasons for using certain procedures (Mirabella et al.). General principles reveal the reasoning behind specific procedures or processes and provide trainees with additional

justification for carrying out of certain operations (Baldwin & Ford, 1988; Gott & Glaser, 1985; Mirabella et al., 1989; Yelon, 1992).

This general understanding is then presented in conjunction with direct teaching about skills and appropriate situations for use (Yelon, 1992). Yelon notes that the promotion of general principles in addition to specific procedures creates a sense of awareness for the learner, informing him or her about the value of certain skills and appropriate times to put skills to use. The learner becomes mindful about the task through the link to the underlying theory. Understanding of only specific steps involved in a procedure or task is not adequate, especially in work environments that are complex or pose many constraints, such as lack of technical support (Gott & Glaser, 1985). Gott and Glaser note that a conceptual knowledge base allows the trainee to be more flexible and to adapt to constraints by enhancing the ability to come up with new solutions in the face of difficulty. Mirabella and colleagues (1989) note that trainees learn procedures faster, retain information longer, work more efficiently, and engage in better problem solving when given information about general principles in relation to the specific procedure.

Research comparing general and specific instructional strategies in terms of aiding transfer has produced conflicting findings. Some research reveals the importance of teaching both the general and the specific, while much other research has found support for the superiority of either teaching the general or specific alone. Some research suggests that specific instruction is useful for using specific information at a later time (specific transfer) but that the use of general strategies (general transfer) is most important for transfer and long-term adaptation (Detterman, 1993). However, since "true" transfer is thought to occur rarely, teaching is most useful when it is specific and practiced in an environment as similar to the target situation as possible (Detterman, 1993). In general, the lack of coherence in the literature is likely due to differences in the definition of transfer and the circumscribed nature of many experimental conditions. Certainly specifics and generalities are both important components of training. Confusion also surrounds issues of elements to include in instruction and those elements important for transfer. In order to analyze the literature as a whole, it is useful to examine the ways in which generalities and specifics are defined.

Several studies support the use of general conceptual instruction for transfer of training (Bassok & Holyoak, 1989; Belmont, Butterfield, & Ferretti, 1982; Fong, Krantz, & Nisbett, 1986; Judd, 1908; Sweller, Mawer, & Ward, 1983; Weisberg, DiCamillo, & Phillips, 1978). A representative study by Bassok and Holyoak (1989) compared transfer in algebra and physics instructional contexts. Two groups of students were taught either the algebra or physics subject matter. The students were then tested for transfer to the other subject matter they had not learned. Those in the algebra group showed superior transfer over those in the physics group. Analysis of this study reveals that those first learning algebra transferred better because algebra is a subject that encourages the learner to seek out principles of other subjects, while physics focuses strictly on the specifics in a particular realm of physics. Those in algebra learned and used general principles; those in physics remained focused only on specific problems and solutions.

Another study arguing for the importance of general conceptual instruction is that of Judd (1908). Subjects engaged in underwater target practice, and were either provided with instruction on general principles of how water refracts light or were not provided with any instruction.

Subjects who were provided with the general theory showed greater evidence of transfer than those deprived of general principles or instruction. Many interpret this study as evidence of the importance of the teaching of general principles for the provision of meaningful learning. Learners without knowledge of underlying principles had no basis for understanding the task, whereas the others could see the connections within the problem (Singley & Anderson, 1989). However, analysis by Detterman (1993) declares that the subjects were simply following directions and did not provide evidence of transfer.

Additional analyses also question the evidence for general transfer (Gray & Orasonu, 1987; Singley & Anderson, 1989). Critics posit that the use of general principles to aid in transfer is an appealing concept to teachers and trainers but, in reality, is only a hopeful possibility for instructional contexts (Singley & Anderson, 1989). Generally, critics believe that learners instructed in general principles are simply not given adequate instruction in how to apply those principles (Singley & Anderson, 1989). Also, general principles tend to be well learned and may be difficult to detect in experimental situations. However, studies such as that of Post and Brennan (1976) have shown that instruction in general skills has no positive effect on specific problem solving. Students instructed in general principles for solving algebra problems performed no better than students not provided with instruction.

Other studies suggest that learning specific skills remains important for transfer of training (Ceci & Liker, 1986; Wason, 1966). Ceci and Liker (1986) engaged two experts at harness racing betting to play a stock market game that depended on the same principles that they regularly used in their betting on the races. Subjects were not informed of the similarity of the general principles underlying their betting and the stock market task. After six hundred trials, the experts were still unaware of the solution that lay in the specific solutions they regularly used in betting on races. Once the similarity was revealed, the subjects quickly found specific solutions to the problem. The authors note that although both tasks required similar solutions, the subjects thought of their racetrack knowledge as specific only to that context and did not apply it generally. The general principles did not transfer despite the task similarity.

Another study arguing for the specificity of transfer is that of Wason (1966). Subjects were given four cards with either a letter or a number printed on them. Subjects were then asked to judge the relevance of a rule pertaining to the four cards, but only 4% chose the correct logic. Analysts of this study suspect that subjects had the ability to understand the logic behind the task but were simply unable to transfer this knowledge to the experimental situation (Singley & Anderson, 1989). Learners tend to use general rules as instructed for specific situations and evaluate other situations without regard to rules used in past circumscribed situations.

An example of support for the importance of including both the general and specific in instruction comes from studies by Mayer and Greeno (1972) and Katona (1940). In the Mayer and Greeno (1972) study, subjects who were taught general concepts performed better on dissimilar transfer tasks, but subjects who were taught specific strategies performed better on specific problems to which the specific formulas were easily applicable. Katona (1940) asked subjects to solve puzzle problems; they were taught either specific formulas for one particular problem or general strategies and principles based on the whole set of problems. Results revealed that subjects who focused on the specific formulas for solution performed better on the specific

memorized problem, but subjects in the general strategy group were better able to transfer to other problems.

Katona (1940) and Mayer and Greeno (1972) show that general and specific strategies are appropriate and useful depending on the nature of the problem to be solved. As mentioned earlier, criticism of the use of general or specific principles must be understood in light of the researcher's interest in learning or transfer. Some are concerned with aiding learning in general, and some are interested in transfer. The use of general or specific principles may not be applied equally for these two types of desired outcomes. In terms of transfer, it is possible that general strategies are most helpful, but specific modes of solution also aid in the training of tasks. Despite contradictions in the literature, perhaps trainers and educators need to find a middle ground and prepare learners with both specific and general types of skills and knowledge. Learners can be well-equipped if provided information about that which can be used across many situations (i.e., general principles) and that which is best used only for specific situations (Ross, 1984; Sternberg & Frensch, 1993). Transfer is essentially the ability to make connections from instructional activities to the real world, and instructors focused on providing students with information on how to use what they learn will be most successful.

Prior knowledge and experience. The literature reveals both the facilitating or inhibitory role of prior knowledge or experience in the likelihood of transfer. Although the effects of prior knowledge are not likely to affect tasks in rather contrived experimental contexts, it is important to pay attention to in more naturalistic settings, like the training environment (Gick & Holyoak, 1987). In addition, success in complex problem-solving tasks, such as those in the digital environment, is more likely for those that are guided by prior knowledge and experience in a domain (Gott & Glaser, 1985). Transfer is inhibited when prior knowledge interferes with a new way of doing or thinking about a task. Subjects in experiments tend to use a familiar technique in problem solving even when a simpler technique is presented to them (Lewis, McAllister, & Adams, 1951; Luchins, 1942; Maier, 1930; Shiffrin & Schneider, 1977). It is difficult to switch from a currently established organization of knowledge of how a task should be performed to an unfamiliar form; the old information hinders transfer. Subjects able to reorganize their knowledge show evidence of transfer (Frensch, 1990). Additionally, prior knowledge can inhibit transfer when new information is presented at the same time (Tulving, 1966).

Research also points to the ease of certain tasks due to prior experience. Rates of learning, in general, are due to prior levels of knowledge (Gagne & Paradise, 1961). Higher level skills cannot be mastered until subordinate skills and knowledge have been mastered. Also, as alluded to earlier, it is most helpful to relate the experimental task to already known concepts that are in keeping with the area of transfer (Burstein, 1986). In one experiment (Brown, Kane, & Echols, 1986), children solving one type of problem easily demonstrated transfer under conditions addressed in their prior experience.

Active use and learning by doing. Transfer is facilitated through active use of knowledge and skills. Bransford (1987) conducted an experiment in which some subjects solved problems through active problem solving activities and others participated in a conventional question and answer format. Those allowed use of the active mode showed greater transfer. Transfer is said to have resulted because the learner is required to pay greater attention to the task in the process of

active use. In addition, actively using the information in a problem-solving situation was the exact situation of the target performance, so a similar context was in place. Subjects in a LOGO programming experiment (Carver & Klahr, 1987), who were explicitly taught a strategy on debugging and ways to apply the strategy, evidenced greater transfer. Emphasis on the strategy and its use are said to have promoted greater attention to the task and to general principles useful for performing in other situations.

Active use of information and skills in training programs is often referred to as "learning by doing" (Mirabella et al., 1989). The emphasis is on the importance of training in an environment that is modeled after the actual work environment (Gott, 1995). In this way, the context of the training environment reveals how the knowledge is actually to be used, unlike with the direct instruction and lecture modes. Direct instruction addresses concepts but does not provide guidelines for use (Mirabella et al.). Certainly some amount of direct instruction will be necessary, but a more optimal training environment also provides group and individual application exercises.

<u>Similarity.</u> A fundamental issue in facilitating transfer is the similarity between the instructional context and the target context. The likelihood of retrieval and transfer increases as the degree of similarity between the two contexts increases (Detterman, 1993; Gick & Holyoak, 1987; Thorndike & Woodworth, 1901). Learners who recognize elements of an earlier situation in a later situation are more successful in applying solutions to the new problem. Early researchers (e.g., Thorndike & Woodworth, 1901) concluded that transfer is a rare event that occurs due to the existence of identical elements in two situations. The amount of transfer that occurs can be surmised from the degree of similarity between the two situations. It is proposed, however, that use of similarity principles should be restricted to training programs desiring near transfer (Noe, 1999). Application of the theory of identical elements is deemed by some to be most appropriate for training environments that are identical to the actual work environment (Noe, 1999). Finally, the issue of similarity invokes debate about the difference between transfer and learning (Detterman, 1993). Performance between two contexts that are very similar can be viewed as learning and not as transfer, although some researchers fail to make this distinction.

In particular, researchers have focused on the similarity between the domains of information in the instructional and target contexts and the similarity of goals for both contexts. Several researchers (Holyoak & Koh, 1987; Reed, Dempster, & Ettinger, 1985) have examined whether similarity of original problems to transfer problems increases the likelihood of transfer. Subjects given two stories that varied structurally were shown to have difficulty with transfer (Holyoak & Koh, 1987). In another study, subjects given two equivalent problems solved the transfer problems correctly more often than those with slightly similar problems (Reed et al.). However, even subjects that received equivalent problems required sample problems to alert them to the high degree of similarity. A similar study (Reed, Ernst, & Banerji, 1974) also found that transfer failure is possible if subjects are not alerted to similarities. In short, similarity between situations facilitates transfer primarily when learners are aware of this fact (Ross, 1984). Detterman (1993) notes that the excessive assistance learners require to alert them to similarities is evidence of how difficult it is to find true transfer. Similarity between tasks can be revealed within the context of the activity by giving subjects examples that are both similar and dissimilar (Tversky & Gati,

1978). Transfer between similar situations is more likely for those that have been exposed to situations both appropriate and inappropriate for use of original skills.

Researchers have noted the importance of goal similarity between tasks for ease of transfer (Gick & Holyoak, 1987). The goal itself cues past experience with similar contexts. Learners use the goal in the target condition to search their memory of prior instructional situations. Goal similarity extends beyond task content to the process of skill and knowledge acquisition. Learners exposed to training and transfer tasks that require similar thought processes and behaviors are more likely to perceive similarity and transfer knowledge between tasks. In training and transfer tasks that allow for processing similarity, subjects are able to develop roughly similar responses to the tasks, and can connect them up in memory. For example, one study (Lund & Dominowski, 1985) found that subjects, who were engaged in a task that required extending and intersecting lines and a transfer task requiring the solution of a dot problem, were able to engage in similar processes and actions to solve both problems. Transfer was facilitated through the use of similar strategies for both tasks. Often goals and modes of processing to be achieved in the instructional context are not similar enough to goals and modes of processing to be achieved in the work environment. Thus some of the primary cues for retrieval, similar goals and processes, are not available.

Practice. Transfer depends on the amount of skill and knowledge acquired in the original instructional context. That skill and knowledge is affected by the use of practice in the initial instruction. When compared to students given full-time lecture instruction, students who are given individual practice time as part of the instruction are more likely to learn and retain skills (Mirabella et al., 1989). Several aspects of practice, such as amount of practice, variability of practice, learner control, and part versus whole-task methods are addressed in the literature.

The question of how much practice is sufficient for transfer and adequate levels of knowledge has been explored in both the experimental and training literatures. Contrary to popular belief, greater amounts of practice do not necessarily lead to larger gains. Large amounts of practice can actually lead to over-training on those parts of the task that are frequently occurring but inadequate training on infrequently occurring, important components (Mirabella et al., 1989). This finding leads to a recommendation for part-task practice on those components that are infrequently presented in the task. Shute, Gawlick and Gluck (1998) found support for a practice-makes-perfect scenario but did not examine the possibility of over-training. This project found that those given the greatest amounts of practice time achieved the highest gains in learning over the short term but at the expense of efficiency. It is important to note that there were no differences in long-term retention for groups given differing amounts of practice. Those with greater practice opportunity gained in the short term, but these effects lessened with time.

Several researchers, who conducted experiments that failed to find adequate levels of transfer, have attributed the results to a lack of practice or initial learning on the part of the participants (Kurland, Pea, Clement, & Mawby, 1986; Perkins, Schwartz, & Simmons, 1988; Reed et al., 1985). In one experiment (Kurland et al.), students with two years of computer classes, including BASIC, were asked to demonstrate their use of BASIC. Subjects failed to demonstrate transfer, in part because they did not practice enough to attain a sufficiently high level of skill. Another experiment focusing on transfer in students in a first semester BASIC

course also found little evidence of transfer (Perkins et al.). Presumably students had not yet had enough practice to develop adequate levels of initial learning for transfer. Finally, students given only a brief problem solving experience with a single algebra problem showed difficulty with transfer (Reed et al.). Students in another condition, given more practice and therefore initial learning opportunities, demonstrated greater levels of transfer.

Learner control is defined as the ability during practice to self-determine how many practice problems to complete before moving on to a new topic (Shute et al., 1998). Trainees are usually given this control or are given strict practice guidelines through program-controlled instruction. Subjects given control over the amount of practice in a computer tutorial experiment chose smaller amounts of practice and required the least amount of overall time to complete the tutorial (Shute et al.). In addition, those in the learner-control condition showed similar levels of short-term success to those in the program-controlled, more extended practice conditions. Thus, efficiency is greater for those given control over their amount of practice. Additionally, it was noted that the learner-control condition benefited trainees with greater amounts of prior knowledge. Mattoon (1994) found similar results for whole-task conditions, but found program-controlled instruction most helpful for performance in part-task conditions.

Variability of learning conditions and variable examples during knowledge and skill acquisition is an additional aid for transfer (Baldwin & Ford, 1988). Studies attributing failure of transfer to small amounts of practice also note that the failure may be due to little variability in the practice (Kurland et al., 1986; Pea & Kurland, 1984; Scribner & Cole, 1981). No learning situations are ever exactly alike. Optimal training introduces variability similar to that found in the actual work environment (Posner & Keele, 1968). Variability in the practice context allows the subject to see how the original skill could be applied in other contexts (Kurland et al.; Pea & Kurland, 1984; Ghodsian et al., 1997). Researchers posit that those with varied experience have developed a set of general rules that allows them to partially predict the necessary steps involved in novel situations (Baldwin & Ford, 1988; Posner & Keele, 1968).

In the training context, variability is important for training materials as well as the conditions of training tasks (Mirabella et al., 1989). It is useful to vary only the aspects of the tasks that are likely to vary in the actual work environment and to point out the similarities and differences in situations to the trainees (Mirabella et al.). Also, it is useful to introduce more variability than would be expected in the actual work environment (Ghodsian et al., 1997). The latter condition might make it easier for the trainee to develop a set of possible solutions and more easily spot what is most appropriate for the particular example at hand (Ghodsian et al.). In addition, it is best to introduce training variability only after an initial period of time in which training conditions are stable.

In order to promote successful learning and transfer, it is necessary to vary the conditions of practice. Some variation in practice can come through the practice of part versus whole-task methods. Part methods focus on breaking the whole task into meaningful units, which are then practiced individually and explained in terms of how they fit into the task as a whole. Whole methods of practice focus on the repetition of the task in its entirety. All aspects of the situation must be considered before determination of the preferred practice conditions and schedule (Mirabella et al., 1989; Teague, Gittelman, & Park, 1994). It is thought that when learners

practice the task in its entirety several times, the parts of the task that occur frequently are subject to over-training and less frequently occurring aspects are not learned as well (Mirabella et al.). Whole methods are acceptable for simple tasks, while part methods should be used for learners with individual difficulties or for complex, time-consuming tasks (Teague et al.). Part methods are also seen as preferable because learners are likely to be reinforced by their successes at performing the small parts correctly. Transfer of learning is most likely for learners exposed to practice conditions that optimally fit the task and the needs of individual.

Several projects (Ash, 1988; Mattoon, 1994) have found that part methods allow learners to perform with less error and increased speed. Part-task methods also may be more beneficial for learners in the long-term (Ash, 1988). Ash (1988) focused on several different types of part and whole methods for discrete perceptual motor tasks, and noted that perhaps the most preferable method is forward chaining, i.e., a part-task method in which the separate practice units follow the natural sequence of the task as a whole. Part methods that simply repeat the difficult portions of the task are not necessarily beneficial, while repetition on the units of the task in natural sequence works well for training. While Mattoon (1994) also found part-task methods beneficial, an interaction with learner control was noted. Subjects in a program-controlled condition performed faster (in terms of response and instructional time) in a part-task practice condition. Subjects in a learner-control condition performed similarly in terms of response time, but those in the whole-task practice condition performed faster in terms of instructional time.

Elaboration methods. Learners are better able to recall information that has been assigned some level of personal significance (Mirabella et al., 1989). Elaboration methods can increase the meaning of information through association with materials and behaviors that are already familiar to trainees. Novick (1990) concluded that subjects, who are given an overall framework for a problem solution, develop a way of representing the problem in their minds. Later problems are more easily solved because subjects have a familiar solution in mind. Generally, students need to be given a framework so that the information is organized (Bransford & Johnson, 1972). The authors showed that subjects given a framework in the form of a story title or caption under a picture showed greater understanding of the material.

Transfer is facilitated when instructional content includes the use of cues or advanced organizers. Advanced organizers are elaboration methods included in instruction that serve as previews of more detailed instruction to follow (Mirabella et al., 1989). Advanced organizers can include introductory outlines and questions or explicit hints on what to look for. It is recognized that advanced organizers are most useful to training if they are directly tied to the instructional content (Mirabella et al.). Several experiments focusing on transfer have investigated the use of cues and hints (Asch, 1969; Bransford, Sherwood, Vye, & Reiser, 1986; Gick & Holyoak, 1980, 1983; Judd 1908; Perfetto, Bransford, & Franks 1983; Schwartz & Humphreys, 1973). In these experiments, subjects were given advanced organizers such as explicit clues, general principles of the task, and preview sentences. However, transfer was facilitated only when subjects were alerted to the clues that had been provided. The advanced organizer is helpful only when subjects are aware of its probable usefulness.

Another useful way to increase the meaning of the task for transfer is through the use of mnemonics (Mirabella et al., 1989). Mnemonics are characters, words, sentences, or pictures that help students to remember facts, rules, or procedures. Sometimes mnemonics are in the form of

similes, metaphors, acronyms, or rhymes. As seen in Dressel (1980), acrostic mnemonics were not helpful in US Army training, but perhaps this is because the mnemonics were not simple enough. It is important to structure the mnemonics so that they are not as difficult as what is to be learned and so that the mnemonic is somehow tied to the subject's prior knowledge.

An experiment by Elio and Anderson (1984) points out the importance of giving early examples that provide exposure to the typical amount of variation. With examples, trainees can generate rules based on the general scope of the examples and the overall similarities that they have seen. Transfer for those who were not instructed to develop a rule for a task was optimized when the most frequently occurring examples were presented first. These subjects naturally categorized and developed many rules based on the similarities they had seen. High-variability examples, those that were more in keeping with the array of features typically present, were best when introduced first for those who were told to develop a rule for the task. Then, the subjects could more easily develop a rule based on representative variation.

Non-instructional Issues

Work environment. In addition to instructional factors, attention must be paid to non-instructional variables in training environments; it is believed that instructional variables may account for only one third of transfer variance (Foxon, 1993). Also, much of the research on instructional factors has been completed in simplified experimental situations that do not take into account many of the non-instructional factors that may operate in real-world environments.

Several factors in the work environment have been identified as influential on transfer of training (Baldwin & Ford, 1988; Noe, 1999; Quinones, 1997). These elements of the environment affect transfer through their influence on the person being trained (Quinones, 1997). Overall, workers are likely to be unmotivated to transfer, or simply overwhelmed, if they perceive that too many constraints are present in the work environment (Facteau, Dobbins, Russell, Ladd, & Kudisch, 1995; Quinones, 1997). These constraints include lack of sufficient work materials, time, information, or equipment. However, based on a training and transfer study on state government employees, it appears that the constraints posed by the work environment have to be relatively severe to affect transfer (Facteau et al.). Nonetheless, in this transitional period in the Army, soldiers whose jobs are being digitized may experience excessive constraints as rapid changes take place. For example, numerous hardware and software upgrades alone are likely to present substantial challenges to those attempting to accomplish tasks through the use of computers. Those being trained on new computer systems may be faced on a frequent basis with extinguishing old-system digital skills while learning new-system skills. Also, the possibility exists for perceived constraints due to computer malfunction and the mixing of digital and non-digital equipment (Salter & Black, 1998; Ford, Campbell, & Cobb, 1998).

In addition to excessive constraints, factors such as supervisor support, reinforcement of training objectives, peer support, opportunity for application of training in the workplace, technological support (Foxon, 1993; Facteau et al., 1995; Noe, 1999), and support for worker autonomy (Baldwin & Ford, 1988) are important to transfer from the training to the work environment. An unsupportive work environment accounts for 42% of all identified inhibiting factors on transfer of training (Foxon, 1993).

Social support for training can come from subordinates, superiors, and peers. These different sources exert differential influence on the outcomes of training (Facteau et al., 1995). Both subordinate and peer support were found to be essential for transfer (Facteau et al.). Support from superiors is believed to be important for both pre-training motivation and for transfer (Facteau et al.). Supervisor support, in particular, is essential to transfer to the extent that supervisors exhibit the same work behaviors expected of their subordinates (Foxon, 1993). Technological support, in the form of job aids or tutorials, could be essential tools to maintain productivity and morale among Army personnel faced with difficulties of the digital transition. Indeed, a positive work environment conducive to transfer embraces continuous learning, knowledge sharing and generation, critical thinking, company-wide promotion of learning, flexibility, and valuing of workers (Noe, 1999). The Army needs to emphasize these goals.

Goal setting and action planning. Goal setting, self-management strategies, and action planning are integral parts of organizational support and trainee motivation (Foxon, 1994; Noe, 1999). It is believed that trainees are more likely to use training in the work setting if they construct or are given goals for how they should use the skills (Foxon, 1994). Goal setting has recently been studied in combination with feedback conditions (Neubert, 1998). Feedback is believed to educate others as to the success of their performance and also serves as a motivator. Thus both goal setting and feedback, as positive strategies, are deemed to be more effective together than each alone. Specifically, Neubert's (1998) meta-analysis focused on goal setting and feedback in combination versus goal setting alone. The effect size (.63) indicates that feedback and goal setting in combination positively affect performance for complex tasks. Also, the meta-analysis revealed that the addition of feedback to goal setting is just as effective for impersonally delivered feedback (e.g., e-mail) as for personally delivered feedback.

Self-management strategies involve the identification of obstacles in the work environment, the construction of a plan to overcome the obstacles, and self-monitoring of progress (Foxon, 1994). When trainees use either goal-setting or self-management strategies, transfer is facilitated (Foxon, 1994; Noe, 1999). One program, based on principles of self-management, is that of relapse prevention. This program addresses typical obstacles in the work environment and ways to deal with the obstacles.

While the above strategies are effective in setting objectives for performance and identifying constraints in the environment, neither strategy addresses the obstacles directly involved in the transfer of training to the work place. An action plan is a written document that includes the steps that the trainee and manager will take to ensure training transfers to the job (Foxon, 1994; Noe, 1999). It identifies problems that might occur, how the manager can help, and defines a meeting schedule to discuss progress and give the supervisor opportunity to dispense feedback. The action plan is revised as needed.

Action planning is differentiated from the other strategies in that supervisor involvement is included and a written commitment is secured for particular behaviors (Foxon, 1994). The lines of communication stay open between trainee and supervisor and, by virtue of the action planning process, the supervisor is supportive and reinforces desired behavior. This eliminates some of the difficulties of the organizational environment. In addition, action planning can incorporate the

transfer-as-process approach rather than just the transfer-as-product approach; transfer-as-process emphasizes continual monitoring and evaluation of progress as opposed to just a focus on the end point (Foxon, 1994). Action planning is a strategy that directly addresses potential obstacles for transfer instead of general environmental factors that may produce transfer failure, as in self-management strategies (Foxon, 1994). Unfortunately, there has been no formal empirical research on action planning as a strategy to facilitate transfer, but it is documented as a suggested strategy for transfer in the training literature (Foxon, 1994).

Motivation. Among the various non-instructional variables that influence transfer, the training literature assigns much importance to trainee motivation. Generally, the literature in this area defines motivation as a choice by a person to strive toward one particular set of behaviors over another (Quinones, 1997). In the work setting, motivation can affect participation in training, amount of effort exerted in training, and whether or not the person chooses to apply what has been learned in training on the job (Quinones, 1997). Foxon (1993) makes an important distinction between motivation to learn and the motivation to transfer. A trainee may be motivated to learn the new skills but, for transfer to occur, must be motivated to transfer the new skills to the work environment.

Several researchers (Noe, 1999; Quinones, 1997) have proposed models that acknowledge the role of trainee characteristics, including motivation to learn, as factors that influence transfer outcomes directly and indirectly. In one study of Air Force technical training programs, individual attributes such as motivation had a greater influence on training performance than the content of the course (Mumford, Harding, Weeks, & Fleishman, 1988). Foxon (1993) writes that levels of motivation-to-learn before training increase when the training itself is viewed as a mandatory feature of the job and when trainees believe that they will have to report back to their supervisors. In addition, a meta-analysis revealed that low levels of motivation account for 13% of all identified inhibiting factors on transfer (Foxon, 1993).

Levels of trainee motivation have been consistently linked with transfer of training. Training for transfer requires high levels of effort and commitment, which potentially can reduce feelings of self-efficacy and expectations for success in the trainee (Hesketh, 1997). Training programs seeking high levels of transfer should seek to increase all possible factors influencing the motivation of the trainee. It is important for training programs to balance the demands placed on the trainee by structuring possibilities for early successes and introducing more difficult tasks later (Hesketh, 1997). Instruction designed to emphasize attention, relevance, confidence, and satisfaction should build student motivation (Mirabella et al., 1997). Further, if trainees are given more choices and control in their training, they may be more motivated (Baldwin & Ford, 1988).

Motivation levels are also influenced by the extent that trainees value and are committed to the training (Baldwin & Ford, 1988; Facteau et al., 1995; Hesketh, 1997). The difficulty and required long-term effort involved in training for transfer may be discounted if those involved are committed from the beginning of the instruction. Also, those that are highly involved with their jobs are more likely to be motivated to train for transfer (Baldwin & Ford, 1988). Finally, as discussed earlier, motivation for transfer can be enhanced by goal setting (Baldwin & Ford, 1988; Hesketh, 1997), meaningful feedback from superiors, and positive trainee perceptions of work environment factors (Baldwin & Ford, 1988).

Relevance of Transfer to Army XXI and Beyond

Enhancing Transfer Through Constructivist Methods

The constructivist approach. Researchers have identified many relevant principles for the design of training environments conducive to transfer of training, but the underlying research dealt mostly with environments that were simplistic, well structured, and predictable such as in classroom instruction. These are not the environments projected to be prototypical of Army XXI. The concept of constructivism has been advanced to improve the transfer of learning, especially under more fluid conditions and for learning digital skills.

Constructivism posits that learners see, structure, pull together, build, and learn to understand information based on prior and current experiences in the learning context (Jonassen, 1994; Marlowe & Page, 1998). The constructivist aim is to create an environment where learners are actively engaged in a search for knowledge (Akyalcin, 1997; Marlowe & Page, 1998). Instructors act as participants and guides, avoiding the traditional role of controlling and dispensing information to students. Knowledge is embedded in the context for learners to discover, analyze, and understand (Marlowe & Page, 1998). Discovery in this sense is not aimed at finding the objective truth but uncovering of information that results in the development and revision of existing ideas (Fosnot, 1992). Traditionally, students have been expected to record, memorize, and repeat information. In contrast, constructivist environments encourage thinking, understanding, and applying information. This active discovery engages the learner in both the content of interest and the learning process itself. However, this active discovery learning process is unappealing to many since it involves a considerable investment of time. Applied, practical exercises and projects are useful ways to integrate constructivist practices into the classroom, although they are not the quickest ways to dispense facts.

The construction of meaning is believed to occur on both the individual and social levels (Jonassen, 1994; Savery & Duffy, 1995). Individuals construct personal meaning based on their own experience and knowledge base and compare that understanding with the perceptions of others (Jonassen, 1994; Prawat & Floden, 1994; Savery & Duffy, 1995). Knowledge can be seen as a social product that is negotiated in a group of learners (Prawat & Floden, 1994). As with many theoretical perspectives, researchers have created different versions of constructivism based on areas of interest, such as cognitive and social factors (Marshall, 1996), and vary in the definition of their concepts.

Constructivist-proposed changes in classroom technique and management. Careful consideration must be given when designing learning environments marked by a constructivist philosophy. At the start, it is important for instructors to evaluate students' level of learning (Feng, 1995). Despite the capabilities of computers to enhance learning environments, basic instruction is still necessary (Bednar, Cunningham, Duffy, & Perry, 1992; Feng, 1995). Students need to be introduced to basic facts and concepts before they can progress to the exploration stressed in a constructivist environment. The basic instruction can be embedded in constructivist learning contexts when necessary but should not be taught as a separate unit of training.

Overall, a constructivist learning environment focuses on three elements – construction, context, and collaboration (Jonassen, 1994). The learning environment should support knowledge construction that involves changing existing mental structures, discussing information with others, and acting in the "real world." The learning context should be made authentic and meaningful for learners by presenting information in terms of real-world examples and through the modeling of others. Collaboration should be encouraged among students and with instructors so that meanings created with others can be used to challenge personal thoughts and knowledge structures.

Proponents of constructivism have described principles to design the training environment (Savery & Duffy, 1995; Murphy & Rheaume, 1997). First, it is important that the learner be informed of the purpose and relevance of each training activity. Next, instructors must work to develop learning goals for the course with the students. Tasks must also be made authentic, in the sense that learners must be exposed to the same types of challenges that would be present on the job. Also, contrary to conventional thinking about instruction, learners must be presented with tasks that are not overly simplified. The environment needs to be designed to scaffold and guide learners through progressively complex tasks. It is also important to enable the learner to decide on problem solving strategies that the student is personally comfortable with through the guidance of the instructor. Finally, learners must be encouraged and guided to engage in reflective and critical thinking. Learners must be given the opportunity to look back on the learning process and content to see how things have been done and what has been learned. Critical thinking skills are engendered by encouraging learners to explore the alternative understandings of others or by comparing personal viewpoints with existing theory. Compared to the traditional training, an environment designed with these types of constructivist elements may produce learners who are better able to actively engage in and use knowledge on the job.

Models used for problem-based learning environments provide an illustration of constructivist principles in action (as in Savery & Duffy, 1995). Students are divided into small groups, each with a guide that presents them with problems to be solved. Students are to solve the problem and be able to articulate rationale and strategies. Students work as a group identifying main issues to resolve and work individually to find resources available to aid in solution of the problem. The group comes together repeatedly to discuss progress and eventually present the solution to others. Assessment is accomplished through suggestions for improvement from peers and measurement of the appropriateness of the original main issues. Learners in this paradigm are actively involved in the search for knowledge, supported by others.

Additional Thinking Skills Research

Discovery learning. Researchers interested in studying thinking skills in discovery learning have tested principles similar to constructivism (McDaniel & Schlager, 1990). Discovery learning is based on the premise that discovering problem solving strategies encourages learners to develop procedures that aid in the generation of novel strategies in future situations. This means that transfer tasks requiring a novel strategy should be easier for learners previously engaged in discovery. Discovery learning is of no benefit in situations where all that is needed is applying a learned strategy. In the first experiment by McDaniel and Schlager, three conditions were established. Participants in one condition were required to discover the strategy and the process of executing the strategy. Subjects in another condition were provided with the strategy

but were left to discover how to execute the strategy. Those in a third group were given direct instruction about the strategy and its execution. Subjects worked on problem solving scenarios and returned after two weeks to solve a problem requiring a similar strategy. The groups did not differ in the degree of transfer due to the similarity of the solutions needed for transfer. Discovery was irrelevant; the needed transfer strategy was learned in the original meeting.

A second experiment (McDaniel & Schlager, 1990) focused on transfer that required use of a different strategy. The group requiring full discovery learning was more successful, presumably because they had practice in generating and testing strategies. However, the authors noted that discovery learning did not impact the success of applying strategies. Thus, discovery is useful if transfer tasks require the generation of new strategies, but application of strategies is a problem for all types of instructional modes.

<u>Metacognition and learning by reflection.</u> Successful problem solvers are aware of task demands, the goals to be accomplished, and the necessary steps for solution (Gott & Glaser, 1985; Jones, Farquhar & Surry, 1995). These learners are adept at adjusting their performance to meet the on-going demands of a task. In general, these types of skills are labeled *metacognitive abilities*. Metacognition includes knowing what one knows and does not know, having an ability to monitor and predict the outcome of the performance, planning, and time management. These monitoring abilities are said to direct the course of procedural and conceptual knowledge. Complex environments, such as digital contexts, call for metacognitive learners.

Principles of metacognition overlap with constructivist approaches. Learners are to be encouraged to select problem solving strategies, attend to those strategies, set goals for a task, and track their progress on meeting those goals through the use of selected strategies (Jones et al., 1995). According to Jones and his colleagues, designing computer learning environments that encourage metacognition requires attention to three main questions. Instructors must be sure that students can use the computer and find the answers to "What is it?", "How do I use it?", and "What do I know?" For answers to "What is it?", the computer program can be given a theme or allow searching the program through maps or tables of content. "How do I use it?" can be answered by presenting multiple options for solving problems, with prompts such as icons. Learners can select the strategies that they wish to use for problem solution as in constructivist environments. The final question, "What do I know?", can be answered by designing the computer environment so that the user can check on his or her progress. This can be in the form of checklists for tasks accomplished. Although complex, these principles could be integrated into the design of computer systems for training to enhance student ability to navigate and actively think about what is to be learned.

A form of metacognitive strategy training is exemplified by McInerney, McInerney & Marsh (1997). In their research, they set up metacognitive strategy training within a cooperative group. Instructors modeled and practiced the use of asking higher order questions to assess progress of learning. Instructors periodically would ask questions of the students such as "What do I still need to know about this subject?" After some time had passed, instructors provided only stems of higher order questions, and individuals discussed their questions and answers within groups of other students. This strategy-training process was found to aid student achievement and self-concept. This simple method of enhancing student metacognition would be easily integrated into

any training setting, prompting learners to engage and develop a deeper understanding of the instruction.

Another empirical study of metacognitive training by Kramarski and Mevarech (1997) provides useful details about how to structure such a program and exemplifies the positive effects that such training can have on student outcomes. Although this training was situated within Logo computer language instruction, its applicability to other contexts is evident. The experimental group received instruction that introduced and consistently reinforced the SOLVE strategy. Students were to engage in <u>S</u>ystematic analysis, <u>O</u>verall planning, <u>L</u>inking together, <u>V</u>erification, and <u>E</u>valuation. This mode of problem solving was encouraged and modeled throughout the course. After the treatment (30 weeks, one hour per week), students in the experimental and control groups were compared on their ability to construct graphs after instruction. They also were interviewed in pairs to solve an additional problem and to discuss their problem-solving processes. Students in the experimental group were shown to construct graphs better and exhibited superior competence in problem solving in areas of information processing, social-cognitive interaction, error detection, and extrapolation. In addition, responses from the structured interview indicated that students from the experimental group engaged in self-reflection about their problem solving process in a much more sophisticated fashion. Kramarski and Mevarech also found that students in the experimental condition frequently mentioned using their newly acquired problem solving processes in other aspects of their life, which is important for the transfer of problem solving skills. Also, it seems likely that those most aware of their thought processes might be able to adapt to complex environments by following and monitoring a given problem to a solution.

<u>Critical thinking</u>. Other researchers interested in thinking skills support the use of critical thinking in students to engender expertise in gathering, analyzing and applying learned material (Bransford, Sherwood, & Sturdevant, 1987; Potts, 1994; Sternberg, 1986, 1987). Principles suggested by those interested in critical thinking can be used to structure the training environment (Potts, 1994). Once again, instructors act as guides, encouraging learners with open questions or problem dilemmas. Instructors are not dispensing facts but asking the learners to engage in the problem and find the necessary information and solution. Learners are encouraged to gather, evaluate, analyze, and use information in a practical sense. Potts believes that instructors need to encourage metacognition by posing compare-and-contrast questions and others like "Why do I think that?" and "What would happen if we solved it this way as opposed to this other way?"

An example of a program for training critical thinking is found in the work of Bransford and colleagues (i.e., Bransford et al., 1987). The course in problem solving is based on five notions of problem solving, summed in the acronym IDEAL. This program focuses on the <u>i</u>dentification of the problem, <u>d</u>efinition of and representation of the problem, <u>e</u>xploration of possible solution strategies, <u>a</u>ction based on the strategies, and <u>l</u>ooking back on the effects of the actions. The guide provided for this program outlines these principles as necessary for improved problem solving and emphasizes the need for practice. The program is geared primarily for those self-directing their critical thinking training, since the program is laid out in a concise booklet outlining underlying theory and exercises.

An additional example of a program for training critical thinking is that of Sternberg (1986; 1987). This program is based on Sternberg's triarchic theory of human intelligence. Briefly, this theory of intelligence focuses on the internal mental processes of the person, the interaction of the person's mental processes and the environment, and the impact of experience. Sternberg emphasizes the importance of teaching for transfer in his program by including a range of practice problems. Also, motivation theory is emphasized in terms of using it for improving critical thinking and recognizing emotional and motivational problems may prevent someone from reaching their potential. Sternberg highlights the teaching of information processing such as the teaching of metacognitive processes, learning about inductive reasoning and making inferences, and knowledge acquisition. This program, in its acknowledgment of the impact of experiences, calls attention to coping with novelty through processes such as selective encoding. This is of note in situations in which problem solvers must selectively process information to decode the relevant from the irrelevant, as is common in ambiguous, changing environments. Finally, attention is paid to the environment in terms of determining appropriate courses of action in various scenarios. Sternberg recommends that this program be implemented over the course of a year, with the minimum time being a semester. In contrast to the Bransford et al. (1987) program, Sternberg (1986) states that his course is best integrated into a classroom curriculum, seemingly adopted as an overarching classroom theme.

The Role of Technology

Effective training for flexible, critical thinking will involve designing the training environment so it can incorporate alternative learning paradigms such as constructivism, metacognition, and critical thinking. This design may include using the capability of new technologies. Computers give learners control over their learning, allow for analytical and critical thinking, and are a good medium to encourage group interaction and collaboration in the classroom (Kosakowski, 1998). Computer programs can provide technical support and helpful information to aid the learner in constructing understandings (Strommen & Lincoln, 1992). Computers are also a good interface for discovery of information and encouraging learners to ask and answer questions within the resources available, thereby developing an awareness of the problem solving process.

Despite the capabilities of computers to enhance learning environments, basic instruction is still necessary (Bednar et al., 1992; Feng, 1995). Basic facts should not be taught in isolation but should be situated in real-world contexts. Essentially, basic concepts should be introduced when necessary for higher-order learning and should not be taught as a separate unit of training. Basic instruction can be embedded in all learning contexts.

Summary and Future Directions

Overall, the research on transfer has been inconclusive due to differences in conceptual definitions, differences in theoretical orientation, and methodological flaws. The literature depicts several categories of instructional and non-instructional factors found to be important. One can surmise that the addition or deletion of any or several of these kinds of factors could affect transfer outcomes. The relative importance of these factors may depend on the conceptualization of transfer, its measurement, and the particular learning environment.

Nonetheless, the concept of transfer is important to training for the digital environments of the Army because of the need for increased soldier flexibility and adaptability. The principles identified in the research on thinking skills, in particular, can be used to create a training environment conducive to transfer.

While the transfer of training and improving transfer in digital environments presents a challenge to the Army training, it should be noted that instructional design may account for only one-third of the variance in transfer of training. Factors such as organizational support, motivation, and constant changes in equipment may also impact the transfer of training. (Foxon, 1993, 1994). This suggests that effective training by itself may not be the whole solution to the full problem of transfer of training to the unit (Hesketh, 1997).

Changes to instruction and the integration of training into the unit are possible. For example, the Army training contexts can be designed to include recommended aspects of instructional design such as elaboration methods as well as increases in practice amount and type. Besides attending to non-instructional constraints, it would be possible for Army trainers to look further into methods for using goal setting and feedback within the training context (Neubert, 1998). This could be effective once trainees are in the unit and working toward goals and receiving feedback about tasks they have learned and equipment they are attempting to use. The use of cues (Asch, 1969; Gick & Holyoak, 1980, 1983) and the use of active problem solving activities (Bransford, 1987) aid in the transfer of knowledge.

Transfer of training is a difficult concept to measure. For practical purposes, this means that it may be difficult to accurately determine whether transfer has occurred or, if it genuinely has not occurred, what happened during the learning process. Generally, transfer has been viewed and measured by many researchers as a product, i.e., an all-or-nothing phenomenon. Unfortunately, this means that transfer is not often tracked after the initial instruction, and information is not available about the process of learning except for what is defined as the endpoint. Learners should be monitored and levels of learning measured over an extended period of time, not just before and at the end of the instructional period. True transfer may not occur for some learners, but it can be determined at what point difficulties become apparent. Measuring transfer as a process impacts how research and training is conducted. It would be useful to teach instructors and trainees about the transfer-as-process view so they are able to understand the utility and the long term implications for training.

Many of the principles suggested by researchers interested in training thinking skills could be usefully integrated into the training environment of the Army. Instructors could adopt or include non-traditional formats so learners could more actively involve themselves in problems and solutions. The computer is an appropriate tool to support this type of non-traditional instruction and can be set up to aid in gathering, storing, and analyzing information. In future research, it would be interesting to compare training environments structured on the bases of different theories and principles for improving thinking skills (e.g., the impact of an constructivist environment versus direct instruction or versus a critical thinking environment). Research integrating principles of thinking skills research in addition to knowledge about transfer has the possibility of uncovering useful principles and guidelines for training in the complex environment of the increasingly digital Army.

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